Amendments to the Specification

Please amend the paragraph on page 1, line 34 to page 2, line 7 as follows:

In the vertical charge transferring portion 501, a vertical p-type well 503 is formed in a surface layer portion of an n^{--}-type semiconductor substrate 502, and an n-type vertical transfer channel 504 is formed in the surface layer portion of the vertical p-type well 503. A plurality of vertical transfer electrodes 507, 509a, and 509b and a final vertical transfer electrode 508 are formed on the surface of the n^{--}-type semiconductor substrate 502 via a gate insulating film 506. The vertical transfer electrodes are wired such that a clock pulse $\phi V1$, $\phi V2$, $\phi V3$, or $\phi V4$ is applied to the vertical transfer electrodes. In the vertical charge transferring portion 501, a p^+-type element ~~separating~~ isolating region 505 for electrically separating between the vertical transfer channels 504 is formed.

Please amend the paragraph on page 2, lines 21-34 as follows:

In the connection portion between the vertical charge transferring portion 501 and horizontal charge transferring portion 510, the p^+-type element ~~separating~~ isolating region 505 extends from the side of the vertical charge transferring portion 501. In this connection portion, the horizontal transfer channel 512 extends from the horizontal charge transferring portion 510 side. The portion of the horizontal transfer channel 512 that extends in the connection portion is placed between the p^+-type element ~~separating~~ isolating regions 505. On the other hand, the vertical transfer channel 504 does not extend in the connection portion, and the end portion 521 thereof on the side of the horizontal charge transferring portion substantially matches the end portion of the final vertical transfer electrode 508. In this connection portion, the n^--type potential barrier region 514 is formed on a portion corresponding to the boundary between the vertical transfer channel 504 and the horizontal transfer channel 512.

Please amend the paragraph on page 4, lines 10-18 as follows:

As shown in FIG. 20, in the connection portion between the vertical charge transferring portion and the horizontal charge transferring portion, a potential barrier 519 is present because of the potential barrier region 514 formed below the second horizontal transfer electrode 515a, and further a potential barrier 520 is present as a result of a narrow channel effect caused by the element ~~separating~~ isolating region 505 of the vertical charge transferring portion. Therefore, the reverse transfer of the signal charge from the horizontal charge transferring portion to the vertical charge transferring portion is prevented.

Please amend the paragraph on page 4, lines 25-37 as follows:

First, as shown in FIGS. 22A and 22B, a protective film 526 is formed on the surface of the n^{--}-type semiconductor substrate 502, and the element ~~separating~~ isolating region 505 is formed by implanting ions of p-type impurities such as boron in a region other than the regions in which a vertical transfer channel and a horizontal transfer channel are to be formed in the surface layer portion of the n^{--}-type semiconductor substrate 502. Then, a first photoresist film 534 is formed on the surface of the protective film 526, and the first photoresist film 534 is removed from the regions in which a vertical transfer channel and a horizontal transfer channel are to be formed, and then a p-type region 524 is formed by implanting ions of p-type impurities such as boron in the surface layer portion of the n^{--}-type semiconductor substrate 502. An n-type region 525 is formed by implanting ions of n-type impurities such as phosphorus or arsenic in the surface layer portion of the p-type region 524.

Please amend the paragraphs on page 7, line 31 to page 11, line 19 as follows:

Therefore, with the foregoing in mind, it is an object of the present invention to provide a solid-state imaging device that can ensure a sufficient amount of transfer charge in each of the vertical charge transferring portions and reduce sufficiently untransferred signal charges that occur when transferring the signal charges from each of the vertical charge transferring portions to the horizontal charge transferring portion and thus can be provided with good display

characteristics, even if the miniaturization of pixels or the low voltage driving in the horizontal charge transferring portion are promoted, and a method for producing such a solid-state imaging device with a high precision.

In order to achieve the above object, a solid-state imaging device of the present invention includes a plurality of vertical charge transferring portions, and a horizontal charge transferring portion that is connected to at least one end of each of the vertical charge transferring portions, receives charges transferred from each of the vertical charge transferring portions and transfers the charges. Each of the [[The]] vertical charge transferring portions includes a vertical transfer channel region of a first conductivity, an element ~~separating~~ isolating region of a second conductivity formed so as to be adjacent to the vertical transfer channel region of the first conductivity, a plurality of vertical transfer electrodes and a final vertical transfer electrode formed on the vertical transfer channel region of the first conductivity, and a vertical well region of the second conductivity formed below the vertical transfer channel region of the first conductivity. The horizontal charge transferring portion includes a horizontal transfer channel region of a first conductivity, and a plurality of horizontal transfer electrodes formed on the ~~vertical~~ horizontal transfer channel region of the first conductivity, and a horizontal well region of the second conductivity formed below the horizontal transfer channel region of the first conductivity. In a connection portion between each of the vertical charge transferring portions and the horizontal charge transferring portion, the vertical transfer channel region of the first conductivity, the element ~~separating~~ isolating region of the second conductivity and the vertical well region of the second conductivity extend from each of the vertical charge transferring portions, and a part of the horizontal transfer electrodes is overlapped on a portion of the vertical transfer channel region of the first conductivity that extends in the connection portion. The end portions of the portions of the vertical transfer channel region of the first conductivity and the vertical well region of the second conductivity that extend in the connection portion on the side of the horizontal charge transferring portion are positioned more on the side of the horizontal charge transferring portion than an end portion of the final vertical transfer electrode on the side

of the horizontal charge transferring portion, and are positioned within 1.5 μm from the end portion of the element ~~separating~~ isolating region of the second conductivity on the side of the horizontal charge transferring portion.

Furthermore, a first production method of the present invention is a method for producing the solid-state imaging device of the present invention and includes forming an ion implantation blocking film on a semiconductor substrate; forming a first photoresist film on the ion implantation blocking film; patterning the first photoresist film and the ion implantation blocking film such that the first photoresist film and the ion implantation blocking film are left on a region to be formed into an element ~~separating~~ isolating region of a second conductivity and are removed from a region to be formed into a vertical transfer channel region of a first conductivity and a horizontal transfer channel region of the first conductivity; forming the vertical transfer channel region of the first conductivity and the horizontal transfer channel region of the first conductivity by implanting ions of impurities of the first conductivity in a surface layer of the semiconductor substrate, and forming a vertical well region of the first conductivity and a horizontal well region of the first conductivity by implanting ions of impurities of the second conductivity below the vertical transfer channel region of the first conductivity and the horizontal transfer channel region of the first conductivity, using the first photoresist film and the ion implantation blocking film as a mask; removing the first photoresist film and then forming a second photoresist film on the semiconductor substrate; patterning the second photoresist film such that the second photoresist is left on the horizontal transfer channel region of the first conductivity and removed from the vertical transfer channel region of the first conductivity; and implanting further ions of impurities of the first conductivity in the vertical transfer channel region of the first conductivity, using the second photoresist film and the ion implantation blocking film as a mask.

Furthermore, a second production method of the present invention is a method for producing the solid-state imaging device of the present invention and includes forming an ion implantation blocking film on a semiconductor substrate; forming a first photoresist film on the

ion implantation blocking film; patterning the first photoresist film and the ion implantation blocking film such that the first photoresist film and the ion implantation blocking film are left on a region to be formed into an element ~~separating~~ isolating region of a second conductivity and are removed from a region to be formed into a vertical transfer channel region of a first conductivity and a horizontal transfer channel region of the first conductivity; forming the vertical transfer channel region of the first conductivity and the horizontal transfer channel region of the first conductivity by implanting ions of impurities of the first conductivity in a surface layer of the semiconductor substrate using the first photoresist film and the ion implantation blocking film as a mask, removing the first photoresist film and then forming a second photoresist film on the semiconductor substrate; patterning the second photoresist film such that the second photoresist is left on the horizontal transfer channel region of the first conductivity and removed from at least the vertical transfer channel region of the first conductivity; forming a vertical well region of the second conductivity by implanting further ions of impurities of the first conductivity in the vertical transfer channel region and implanting ions of impurities of the second conductivity below the vertical transfer channel region, using the second photoresist film and the ion implantation blocking film as a mask; removing the second photoresist film and the ion implantation blocking film and then forming a third photoresist film on the semiconductor substrate; patterning the third photoresist film such that the third photoresist film is left at least on the vertical transfer channel region of the first conductivity and removed from the horizontal transfer channel region of the first conductivity; and forming a vertical well region of the second conductivity by implanting ions of impurities of the second conductivity below the horizontal transfer channel region, using the third photoresist film as a mask.

Furthermore, a third production method of the present invention is a method for producing the solid-state imaging device of the present invention and includes forming a first photoresist film on a semiconductor substrate; patterning the first photoresist film such that the first photoresist film is left on a region to be formed into an element ~~separating~~ isolating region

of a second conductivity and is removed from a region to be formed into a vertical transfer channel region of a first conductivity and a horizontal transfer channel region of the first conductivity; forming the vertical transfer channel region of the first conductivity and the horizontal transfer channel region of the first conductivity by implanting ions of impurities of the first conductivity in a surface layer of the semiconductor substrate using the first photoresist film as a mask, and forming a vertical well region of the first conductivity and a horizontal well region of the first conductivity by implanting ions of impurities of the second conductivity below the vertical transfer channel region of the first conductivity and the horizontal transfer channel region of the first conductivity; removing the first photoresist film and then forming a second photoresist film on the semiconductor substrate; patterning the second photoresist film such that the second photoresist is left on a region to be formed into an element ~~separating~~ isolating region of the second conductivity and the horizontal transfer channel region of the first conductivity and is removed from the horizontal transfer channel region of the first conductivity; and implanting further ions of impurities of the second conductivity in the horizontal transfer channel region of the first conductivity, using the second photoresist film as a mask.

In the third production method, it is preferable that the method further includes implanting ions of impurities of the first conductivity in the horizontal well region of the second conductivity, using the second photoresist film as a mask.

According to the solid-state imaging device of the present invention, even if the difference in the n-type impurity concentration between each of the vertical transfer channels and the horizontal transfer channel is increased in order to increase the amount of transfer charge of each of the vertical charge transferring portions or the low voltage driving of the horizontal charge transferring portion is promoted, the signal charges can be transferred to the horizontal charge transferring portion smoothly in a short time. Consequently, the miniaturization of pixels, the high-speed driving of each of the vertical charge transferring portions and the low voltage driving of the horizontal charge transferring portion can be promoted.

Please amend the paragraph on page 8, lines 3-34 as follows:

In order to achieve the above object, a solid-state imaging device of the present invention includes a plurality of vertical charge transferring portions, and a horizontal charge transferring portion that is connected to at least one end of each of the vertical charge transferring portions, receives charges transferred from each of the vertical charge transferring portions and transfer the charges. Each of the [[The]] vertical charge transferring portion includes a vertical transfer channel region of a first conductivity, an element ~~separating~~ isolating region of a second conductivity formed so as to be adjacent to the vertical transfer channel region of the first conductivity, a plurality of vertical transfer electrodes and a final vertical transfer electrode formed on the vertical transfer channel region of the first conductivity, and a vertical well region of the second conductivity formed below the vertical transfer channel region of the first conductivity. The horizontal charge transferring portion includes a horizontal transfer channel region of a first conductivity, and a plurality of horizontal transfer electrodes formed on the ~~vertical~~ horizontal transfer channel region of the first conductivity, and a horizontal well region of the second conductivity formed below the horizontal transfer channel region of the first conductivity. In a connection portion between each of the vertical charge transferring portions and the horizontal charge transferring portion, the vertical transfer channel region of the first conductivity, the element ~~separating~~ isolating region of the second conductivity and the vertical well region of the second conductivity extend from each of the vertical charge transferring portions, and a part of the horizontal transfer electrodes is overlapped on a portion of the vertical transfer channel region of the first conductivity that extends in the connection portion. The end portions of the portions of the vertical transfer channel region of the first conductivity and the vertical well region of the second conductivity that extend in the connection portion on the side of the horizontal charge transferring portion are positioned more on the side of the horizontal charge transferring portion than an end portion of the final vertical transfer electrode on the side of the horizontal charge transferring portion, and are positioned within 1.5 μm from the end

portion of the element ~~separating~~ isolating region of the second conductivity on the side of the horizontal charge transferring portion.

Please amend the paragraph on page 8, line 35 to page 9, line 23 as follows:

Furthermore, a first production method of the present invention is a method for producing the solid-state imaging device of the present invention and includes forming an ion implantation blocking film on a semiconductor substrate; forming a first photoresist film on the ion implantation blocking film; patterning the first photoresist film and the ion implantation blocking film such that the first photoresist film and the ion implantation blocking film are left on a region to be formed into an element ~~separating~~ isolating region of a second conductivity and are removed from a region to be formed into a vertical transfer channel region of a first conductivity and a horizontal transfer channel region of the first conductivity; forming the vertical transfer channel region of the first conductivity and the horizontal transfer channel region of the first conductivity by implanting ions of impurities of the first conductivity in a surface layer of the semiconductor substrate, and forming a vertical well region of the first conductivity and a horizontal well region of the first conductivity by implanting ions of impurities of the second conductivity below the vertical transfer channel region of the first conductivity and the horizontal transfer channel region of the first conductivity, using the first photoresist film and the ion implantation blocking film as a mask; removing the first photoresist film and then forming a second photoresist film on the semiconductor substrate; patterning the second photoresist film such that the second photoresist is left on the horizontal transfer channel region of the first conductivity and removed from the vertical transfer channel region of the first conductivity; and implanting further ions of impurities of the first conductivity in the vertical transfer channel region of the first conductivity, using the second photoresist film and the ion implantation blocking film as a mask.

Please amend the paragraphs on page 9, line 24 to page 11, line 5 as follows:

Furthermore, a second production method of the present invention is a method for producing the solid-state imaging device of the present invention and includes forming an ion implantation blocking film on a semiconductor substrate; forming a first photoresist film on the ion implantation blocking film; patterning the first photoresist film and the ion implantation blocking film such that the first photoresist film and the ion implantation blocking film are left on a region to be formed into an element ~~separating~~ isolating region of a second conductivity and are removed from a region to be formed into a vertical transfer channel region of a first conductivity and a horizontal transfer channel region of the first conductivity; forming the vertical transfer channel region of the first conductivity and the horizontal transfer channel region of the first conductivity by implanting ions of impurities of the first conductivity in a surface layer of the semiconductor substrate using the first photoresist film and the ion implantation blocking film as a mask, removing the first photoresist film and then forming a second photoresist film on the semiconductor substrate; patterning the second photoresist film such that the second photoresist is left on the horizontal transfer channel region of the first conductivity and removed from at least the vertical transfer channel region of the first conductivity; forming a vertical well region of the second conductivity by implanting further ions of impurities of the first conductivity in the vertical transfer channel region and implanting ions of impurities of the second conductivity below the vertical transfer channel region, using the second photoresist film and the ion implantation blocking film as a mask; removing the second photoresist film and the ion implantation blocking film and then forming a third photoresist film on the semiconductor substrate; patterning the third photoresist film such that the third photoresist film is left at least on the vertical transfer channel region of the first conductivity and removed from the horizontal transfer channel region of the first conductivity; and forming a vertical well region of the second conductivity by implanting ions of impurities of the second conductivity below the horizontal transfer channel region, using the third photoresist film as a mask.

Furthermore, a third production method of the present invention is a method for producing the solid-state imaging device of the present invention and includes forming a first photoresist film on a semiconductor substrate; patterning the first photoresist film such that the first photoresist film is left on a region to be formed into an element ~~separating~~ <u>isolating</u> region of a second conductivity and is removed from a region to be formed into a vertical transfer channel region of a first conductivity and a horizontal transfer channel region of the first conductivity; forming the vertical transfer channel region of the first conductivity and the horizontal transfer channel region of the first conductivity by implanting ions of impurities of the first conductivity in a surface layer of the semiconductor substrate using the first photoresist film as a mask, and forming a vertical well region of the first conductivity and a horizontal well region of the first conductivity by implanting ions of impurities of the second conductivity below the vertical transfer channel region of the first conductivity and the horizontal transfer channel region of the first conductivity; removing the first photoresist film and then forming a second photoresist film on the semiconductor substrate; patterning the second photoresist film such that the second photoresist is left on a region to be formed into an element ~~separating~~ <u>isolating</u> region of the second conductivity and the horizontal transfer channel region of the first conductivity and is removed from the horizontal transfer channel region of the first conductivity; and implanting further ions of impurities of the second conductivity in the horizontal transfer channel region of the first conductivity, using the second photoresist film as a mask.

Please amend the paragraph on page 9, line 24 to page 11, line 5 as follows:

FIG. 5 is a graph showing the results of analyzing the potential barrier and the potential depression occurring between <u>each of</u> the vertical charge transferring portion<u>s</u> and the horizontal charge transferring portion when the position of the end portion of the vertical transfer channel is shifted with respect to the end portion of the element ~~separating~~ <u>isolating</u> region.

Please amend the paragraph on page 14, line 30 to page 15, line 15 as follows:

According to the solid-state imaging device of the present invention, as described above, the vertical transfer channel region of a first conductivity, the element ~~separating~~ isolating region of a second conductivity and the vertical well region of the second conductivity are extended to the connection portion between each of the vertical charge transferring portions and the horizontal charge transferring portion, and the end portions of the extended portions of the vertical transfer channel region of the first conductivity and the vertical well region of the second conductivity on the side of the horizontal charge transferring portion are positioned more on the side of the horizontal charge transferring portion than the end portion of the final vertical transfer electrode on the side of the horizontal charge transferring portion, and are positioned within 1.5 μm from the end portion of the element ~~separating~~ isolating region of the second conductivity on the side of the horizontal charge transferring portion. Thus, even if the difference in the n-type impurity concentration between the vertical transfer channel and the horizontal transfer channel is increased in order to increase the amount of transfer charge of each of the vertical charge transferring portions or the low voltage driving of the horizontal charge transferring portion is promoted, signal charges can be transferred to the horizontal charge transferring portion smoothly in a short time. Therefore, the miniaturization of pixels, the high-speed driving of each of the vertical charge transferring portions and the low voltage driving of the horizontal charge transferring portion can be promoted further while ensuring good display characteristics.

Please amend the paragraph on page 17, lines 10-19 as follows:

As shown in FIGS. 2A and 2B, in the vertical charge transferring portion 101, a vertical p-type well 103 is formed in a surface layer portion of an n^{--}-type semiconductor substrate 102, and an n-type vertical transfer channel 104 is formed in the surface layer portion of the vertical p-type well 103. Furthermore, a p^+-type element ~~separating~~ isolating region 105 is formed

between the vertical transfer channels 104. A plurality of vertical transfer electrodes 107, 109a and 109b and a final vertical transfer electrode 108 are formed on the vertical transfer channel 104 via a gate insulating film 106. The vertical transfer electrodes are wired such that a clock pulse ϕV1, ϕV2, ϕV3, or ϕV4 is applied to the vertical transfer electrodes.

Please amend the paragraphs on page 18, lines 3-26 as follows:

In the connection portion between each of the vertical charge transferring portions and the horizontal charge transferring portion, the vertical p-type well 103, the p^+-type element ~~separating~~ isolating region 105 and the vertical transfer channel 104 extend from the vertical charge transferring portion side. In this connection portion, the p^+-type element ~~separating~~ isolating region 105 is formed so as to be overlapped on the end portion of the second horizontal transfer electrode 115b on the side of the vertical charge transferring portion. The vertical transfer channel 104 is formed so as to be overlapped on the end portions of the first horizontal transfer electrode 113a and the second horizontal transfer electrode 115a that receive the charges transferred from the vertical charge transferring portion 101 on the side of the vertical charge transferring portion. Furthermore, in this connection portion, the n^--type potential barrier region 114 is formed in a gap between the final vertical transfer electrode 108 and the first horizontal transfer electrode 113a, and the second horizontal transfer electrode 115a is overlapped on the potential barrier region 114 via the gate insulating film 106.

In this solid-state imaging device, the vertical p-type well 103, the vertical transfer channel 104 and the p^+-type element ~~separating~~ isolating region 105 extend in the connection portion between vertical charge transferring portion 101 and the horizontal charge transferring portion 110, as described above, and the positions of the end portions 121 of the vertical p-type well 103 and the vertical transfer channel 104 are adjusted so as to substantially match the

position of the end portion 116 of the p-type element ~~separating~~ isolating region 105 on the side of the horizontal charge transferring portion.

Please amend the paragraphs on page 20, lines 2-21 as follows:

As shown in FIG. 3, in the connection portion between each of the vertical charge transferring portions and the horizontal charge transferring portion, a potential barrier 119 is present because of the potential barrier region 114 formed below the second horizontal transfer electrode 115a, and further a potential barrier 120 is present as a result of a narrow channel effect caused by the element ~~separating~~ isolating region 105 of the vertical charge transferring portion. Therefore, the reverse transfer of the signal charge from the horizontal charge transferring portion to the vertical charge transferring portion is prevented.

Next, the effect achieved by such a solid-state imaging device will be described with reference to FIGS. 2 and 3. As described above, this solid-state imaging device is formed such that the vertical transfer channel 104 and the element ~~separating~~ isolating region 105 extend in the connection portion between the vertical charge transferring portion 101 and the horizontal charge transferring portion 110, and the position of the end portion 121 of the vertical transfer channel 104 substantially matches the position of the end portion of the element ~~separating~~ isolating region 105. In other words, the region below the final vertical transfer electrode 108 and the region below the first horizontal transfer electrode 113a in the connection portion have substantially the same impurity concentration.

Please amend the paragraphs on page 21, lines 3-25 as follows:

The more the n-type impurity concentration of the vertical transfer channel 104 is higher than that of horizontal transfer channel 112, the lower the potential barrier 120 generated by the narrow channel effect of the element ~~separating~~ isolating region 105 of the vertical charge

transferring portion is. Therefore, it is preferable to set the n-type impurity concentration of the vertical transfer channel 104 to be higher than that of horizontal transfer channel 112 within the range in which the potential barrier 120 does not appear.

In the connection portion, it is preferable that the end portion 121 of the vertical transfer channel 104 and the end portion 116 of the p^+-type element ~~separating~~ isolating region 105 are formed such that the positions thereof substantially match each other. However, since the channel potential from the vertical charge transferring portion 101 to the horizontal charge transferring portion 110 changes so as to be gradually deeper because of the narrow channel effect, if the position of the end portion 121 of the vertical transfer channel 104 is within this range of the changing region 133 of this channel potential, the potential depression or the generation of a barrier can be suppressed sufficiently, and it is possible to achieve the above-described effect. More specifically, the end portion 121 of the vertical transfer channel 104 can be positioned more on the side of the horizontal charge transferring portion than the end portion of the final vertical transfer electrode 108 on the side of the horizontal charge transferring portion and be positioned within 1.5 μm from the end portion 116 of the p^+-type element ~~separating~~ isolating region 105.

Please amend the paragraphs on page 22, line 18 to page 23, line 15 as follows:

FIG. 4 shows the channel potential distribution from each of the vertical charge transferring portions to the horizontal charge transferring portion of the solid-state imaging device that is formed under these conditions and driven. FIG. 4 shows the channel potential distributions in the following cases: the position of the end portion 121 of the vertical transfer channel is shifted by 2 μm to the side of the vertical charge transferring portion with respect to the position of the end portion 116 of the element ~~separating~~ isolating region (I), the positions are

matched (II), and the position of the end portion 121 of the vertical transfer channel is shifted by 2 μm to the side of the horizontal charge transferring portion.

When the position of the end portion 121 of the vertical transfer channel is matched to the position of the end portion 116 of the element ~~separating~~ isolating region (II), the channel potential below the final vertical transfer electrode 108 (to which $V_{VH} = 0V$ is applied) is about 6V because of the narrow channel effect, the channel potential of a region (potential barrier region 114) positioned below the second horizontal transfer electrode 115a (to which $V_{HH} = 3V$ is applied) in the connection portion is about 7V because of the narrow channel effect, and the channel potential of a region (vertical transfer channel 104) positioned below the first horizontal transfer electrode 113a (to which $V_{HH} = 3V$ is applied) in the connection portion is about 8V because of the narrow channel effect. On the other hand, the channel potential of a region (horizontal transfer channel 112) positioned below the first horizontal transfer electrode 113a (to which $V_{HH} = 3V$ is applied) in the horizontal charge transferring portion is about 10V because there is almost no narrow channel effect. Thus, the channel potential is formed so as to become gradually deeper from the final vertical transfer electrode 108 to the horizontal transfer channel 112, so that the signal charge can be transferred from the vertical charge transferring portion 101 to the horizontal charge transferring portion 110 smoothly in a short time.

Furthermore, when the position of the end portion 121 of the vertical transfer channel is shifted to the side of the vertical charge transferring portion with respect to the end portion 116 of the element ~~separating~~ isolating region, a potential barrier tends to occur, and when it is shifted to the side of the horizontal charge transferring portion, a potential depression tends to occur (I and III).

Please amend the paragraphs on page 23, lines 16-27 as follows:

FIG. 5 is a graph showing the results of analyzing the magnitude of the potential barrier and the potential depression occurring between the vertical charge transferring portion and the horizontal charge transferring portion by simulation when the position of the end portion 121 of the vertical transfer channel is shifted to the side of the vertical charge transferring portion and the side of the horizontal charge transferring portion with respect to the end portion 116 of the element ~~separating~~ isolating region 105. As shown in these results, when the shift between the position of the end portion 121 of the vertical transfer channel and the end portion 116 of the element ~~separating~~ isolating region is within 1.5 μm or less, substantially no potential barrier or potential depression occur, and the occurrence of abnormal display such as appearance of vertical lines called black line defects can be suppressed.

Please amend the paragraph on page 23, line 36 to page 24, line 12 as follows:

As shown in FIGS. 6A and 6B, a protective film 126 such as an oxide film is formed on the surface of the n^{--}-type semiconductor substrate 102. An ion implantation blocking film 135 such as a nitride film is formed on the protective film 126, and a first photoresist film 134 is formed on the surface of the ion implantation blocking film 135. Then, the first photoresist film 134 and the ion implantation blocking film 135 are patterned and removed such that the first photoresist film 134 and the ion implantation blocking film 135 are removed from the region where a vertical transfer channel and a horizontal transfer channel are to be formed, and are left on the portion to be formed into the element ~~separating~~ isolating region. Thereafter, a p-type region 124 is formed by implanting ions of p-type impurities such as boron into the surface layer portion of the n^{--}-type semiconductor substrate 102, and an n-type region 125 is formed by implanting ions of n-type impurities such as phosphorus or arsenic into the surface layer portion of the p-type region 124.

Please amend the paragraphs on page 24, line 30 to page 25, line 15 as follows:

At this point, the shift between the positions of the boundary between the vertical transfer channel and the horizontal transfer channel (the end portion 121 of the vertical transfer channel on the side of the horizontal charge transferring portion) and the boundary between the vertical p-type well and the horizontal p-type well (the end portion 137 of the vertical p-type well on the side of the horizontal charge transferring portion), and the position of the end portion of the region to be formed into the element ~~separating~~ isolating region 105 on the side of the horizontal charge transferring portion (corresponding to reference numeral 116 of FIG. 7B) is adjusted so as to be within 1.5 μm.

Then, after the second photoresist film 128 and the ion implantation blocking film 135 are removed entirely, as shown in FIGS. 8A and 8B, the element ~~separating~~ isolating region 105 is formed by implanting ions of p-type impurities such as boron into the region other than the vertical transfer channel and the horizontal transfer channel of the surface layer portion of the n^{--}-type semiconductor substrate 102. After the protective film 126 is removed entirely, a gate insulating film 106 is formed on the surface, and transfer electrodes 107, 108, 113a, and 113b of the first layer are formed on the gate insulating film 106. Furthermore, a third photoresist film 129 is formed on the surface and then removed from the region on the side of the horizontal transfer channel so as to have the end portion on the final vertical transfer electrode 108. Thereafter, an n^{-}-type potential barrier region 114 is formed by implanting ions of p-type impurities such as boron.

Please amend the paragraph on page 26, line 26 to page 27, line 1 as follows:

First, as shown in FIGS. 10A and 10B, a protective film 226 such as an oxide film is formed on the surface of the n^{--}-type semiconductor substrate 202. An ion implantation blocking film 235 such as a nitride film is formed on the protective film 226, and a first photoresist film

234 is formed on the surface of the ion implantation blocking film 235. Then, the first photoresist film 234 and the ion implantation blocking film 235 are patterned and removed such that the first photoresist film 234 and the ion implantation blocking film 235 are removed from the region where a vertical transfer channel and a horizontal transfer channel are to be formed, and are left on the portion to be formed into the element ~~separating~~ isolating region. Thereafter, an n-type region 225 is formed by implanting ions of n-type impurities such as phosphorus or arsenic into the surface layer portion of the n^{--}-type semiconductor substrate 202.

Please amend the paragraph on page 27, lines 17-23 as follows:

At this point, the shift between the position of the boundary between the vertical transfer channel and the horizontal transfer channel (the end portion 221 of the vertical transfer channel on the side of the horizontal charge transferring portion) and the position of the end portion of the region to be formed into the p^+-type element ~~separating~~ isolating region 205 on the side of the horizontal charge transferring portion (corresponding to reference numeral 216 of FIG. 11B) is adjusted so as to be within 1.5 μm.

Please amend the paragraphs on page 27, line 33 to page 28, line 15 as follows:

At this point, the shift between the position of the boundary between the vertical p-type well and the horizontal p-type well (the end portion 237 of the vertical p-type well on the side of the horizontal charge transferring portion) and the position of the end portion of the region to be formed into the p^+-type element ~~separating~~ isolating region 205 on the side of the horizontal charge transferring portion (corresponding to reference numeral 216 of FIG. 13B) is adjusted so as to be within 1.5 μm.

Then, after the third photoresist film 229 is removed entirely, as shown in FIGS. 13A and 13B, the element ~~separating~~ isolating region 205 is formed by implanting ions of p-type impurities such as boron onto the region other than the vertical transfer channel and the horizontal transfer channel of the surface layer portion of the n^{--}-type semiconductor substrate 202. After the protective film 226 is removed entirely, a gate insulating film 206 is formed on the surface, and transfer electrodes 207, 208, 213a, and 213b of the first layer are formed on the gate insulating film 206. Furthermore, a fourth photoresist film 236 is formed on the surface and then removed from the region on the side of the horizontal transfer channel so as to have the end portion on the final vertical transfer electrode 208. Thereafter, an n^{-}-type potential barrier region 214 is formed by implanting ions of p-type impurities such as boron.

Please amend the paragraphs on page 29, line 26 to page 30, line 26 as follows:

As shown in FIGS. 15A and 15B, a protective film 326 such as an oxide film is formed on the surface of the n^{--}-type semiconductor substrate 302. A first photoresist film 334 is formed on the surface of the protective film 326. Then, the first photoresist film 334 is patterned and removed such that the first photoresist film 334 is left on the region to be formed into an element ~~separating~~ isolating region and is removed from on the region where a vertical transfer channel and a horizontal transfer channel are to be formed. Thereafter, a p-type region 324 is formed by implanting ions of p-type impurities such as boron into the surface layer portion of the n^{--}-type semiconductor substrate 302, and an n-type region 325 is formed by implanting ions of n-type impurities such as phosphorus or arsenic into the surface layer portion of the p-type region 324.

Then, the first photoresist film 334 is removed entirely, and a second photoresist film 328 is formed on the surface of the protective film 326. As shown in FIGS. 16A and 16B, the second photoresist film 328 is patterned and removed such that the second photoresist film 328 is left on the regions to be formed into an element ~~separating~~ isolating region and a vertical channel

region, and is removed from the region where a horizontal transfer channel is to be formed. Using as a mask the second photoresist film 328 that is left, a horizontal p-type well 311 having a low concentration is formed by implanting ions of n-type impurities such as phosphorus or arsenic in substantially the same depth as the p-type region 324, and a horizontal transfer channel 312 having a low concentration is formed by implanting ions of p-type impurities such as boron in substantially the same depth as the n-type region 325. The portions of the p-type region 324 and the n-type region 325 in which the horizontal p-type well 311 and the horizontal transfer channel 312 are not formed serve as a vertical p-type well 303 and a vertical transfer channel 304, respectively.

At this point, the shift between the positions of the boundary between the vertical transfer channel and the horizontal transfer channel (the end portion 321 of the vertical transfer channel on the side of the horizontal charge transferring portion) and the boundary between the vertical p-type well and the horizontal p-type well (the end portion 337 of the vertical p-type well on the side of the horizontal charge transferring portion), and the position of the end portion of the region to be formed into the p^+-type element ~~separating~~ isolating region 305 on the side of the horizontal charge transferring portion (corresponding to reference numeral 316 of FIG. 17B) is adjusted so as to be within 1.5 μm.

Then, after the second photoresist film 328 is removed entirely, as shown in FIGS. 17A and 17B, the element ~~separating~~ isolating region 305 is formed by implanting ions of p-type impurities such as boron into the region other than the vertical transfer channel and the horizontal transfer channel of the surface layer portion of the n^{--}-type semiconductor substrate 302. After the protective film 326 is removed entirely, a gate insulating film 306 is formed on the surface, and transfer electrodes 307, 308, 313a, and 313b of the first layer are formed on the gate insulating film 306. Furthermore, a third photoresist film 329 is formed on the surface and then removed from the region on the side of the horizontal transfer channel so as to have the end

portion on the final vertical transfer electrode 308. Thereafter, an n^--type potential barrier region 314 is formed by implanting ions of p-type impurities such as boron.